(12) UK Patent Application (19) GB (11) 2 293 526 (13) A

(43) Date of A Publication 27.03.1996

(21) Application No 9518836.3

(22) Date of Filing 14.09.1995

(30) Priority Data
(31) 08311467 (32) 23.09.1994 (33) US

(71) Applicant(s)
Motorola Inc

(Incorporated in USA - Delaware)

1303 East Algonquin Road, Schaumburg, Illinois 60196, United States of America

(72) Inventor(s)
David L Weigand
Charles John Malek

(74) Agent and/or Address for Service
Christopher Stanislaw Hirsz
Motorola Limited, European Intellectual Property Operation, Midpoint, Alencon Link, BASINGSTOKE, Hampshire, RG21 7PL, United Kingdom

(51) INT CL[6]
H04B 7/212

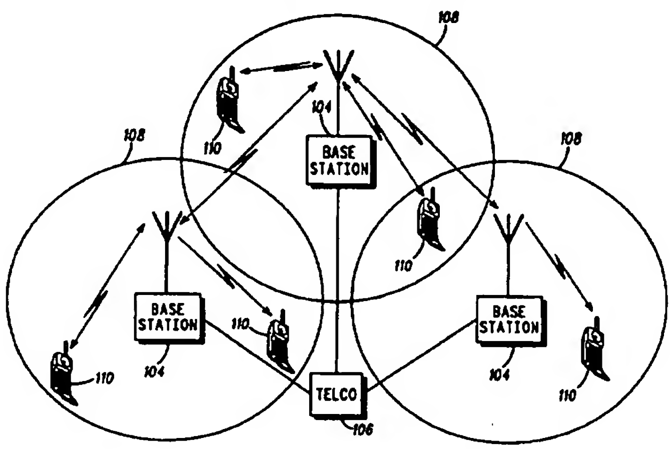
(52) UK CL (Edition O)
H4L LDLX L1H10 L1H3

(56) Documents Cited
EP 0626796 A1 EP 0592209 A1 EP 0578506 A2
WO 94/28643 A1 WO 94/22245 A1 WO 94/18764 A1
US 5448570 A US 5388102 A US 4887266 A
WPI ACCESSION NUMBER 95-176189 & JP070099473 (93-JP-241565)

(58) Field of Search
UK CL (Edition N) H4L LDLX LDSX
INT CL[6] H04B 7/212 7/26, H04Q 7/30

(54) Providing synchronous communication

(57) Synchronous communication in a digital cellular communication environment 102 wherein multiple base stations 104 are adapted to operate on the same frequencies. The base stations 104 which operate within range of one another must be coordinated to minimize interference with other base stations 104 which may otherwise operate independently. A first base station operating in a system will determine whether another base station operating on the same frequencies is within range. The first base station will assume a role as a master and the second base station will then synchronize to the master base station. The master base station will transmit a beacon signal in a time slot, any base station in range not synchronised to another will then synchronise itself to this beacon and retransmit the beacon. With this method, all base stations within range of another will become synchronised together. The preferred methods for synchronizing the base stations include signalling protocols and collision avoidance techniques for digital multiple access communication systems.



F I G. 1 102

GB 2 293 526 A

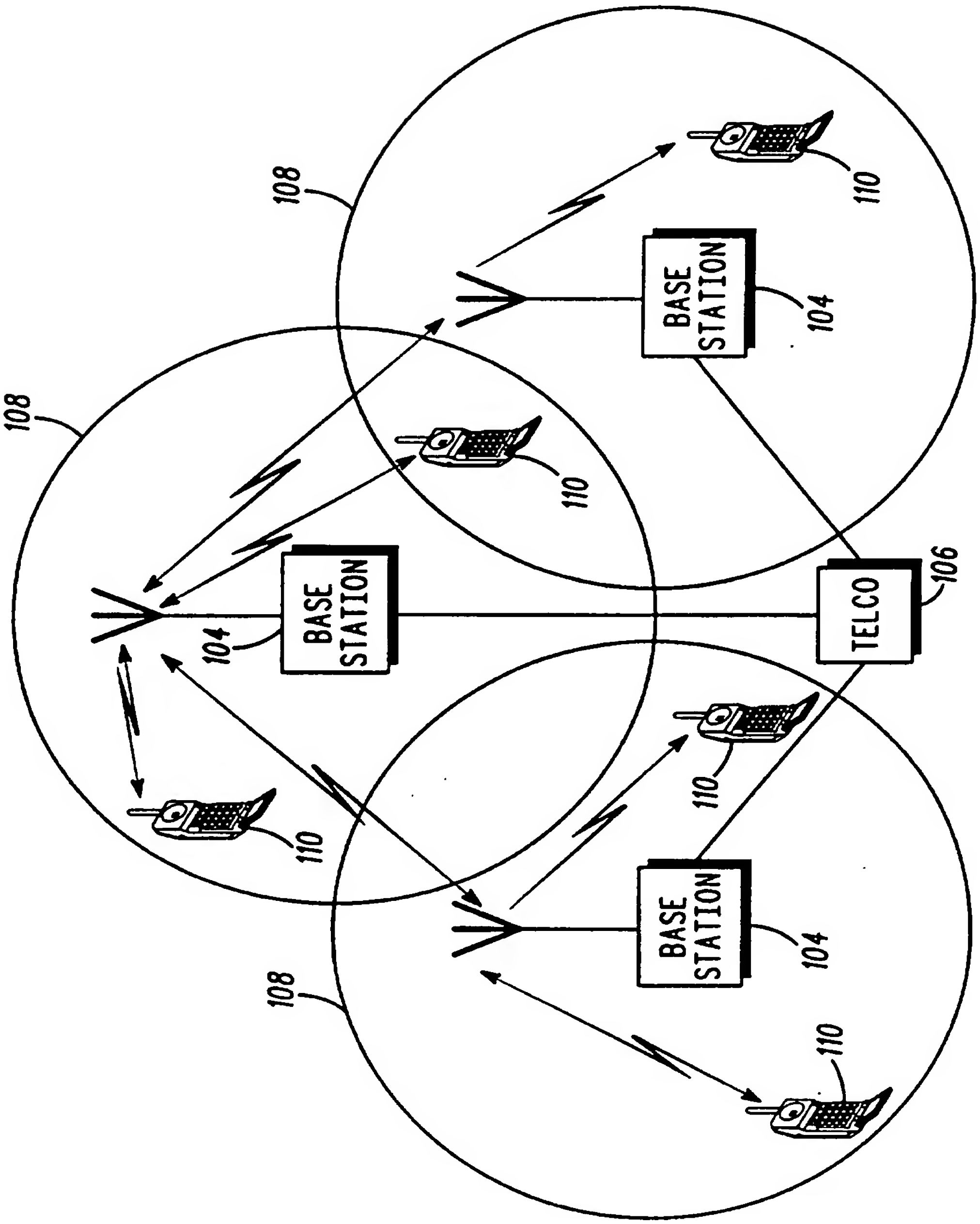

108
108
108
BASE STATION
BASE STATION
BASE STATION
104
104
104
TELCO
106
110
110
110
110
110

FIG.1 102

FIG.2

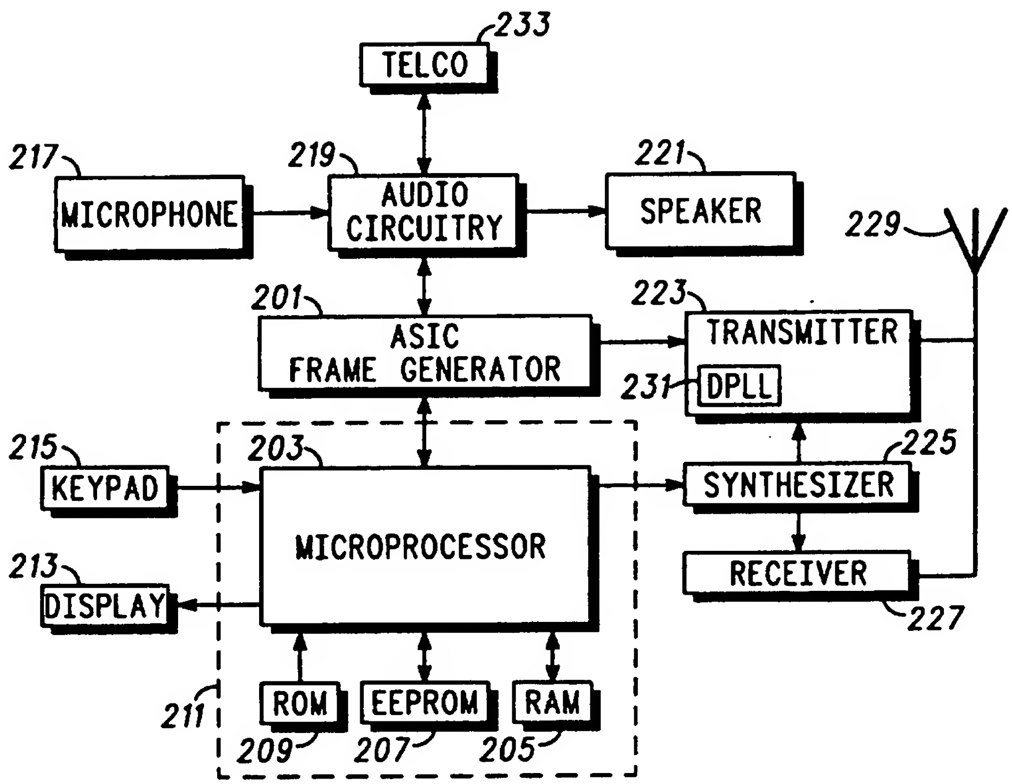
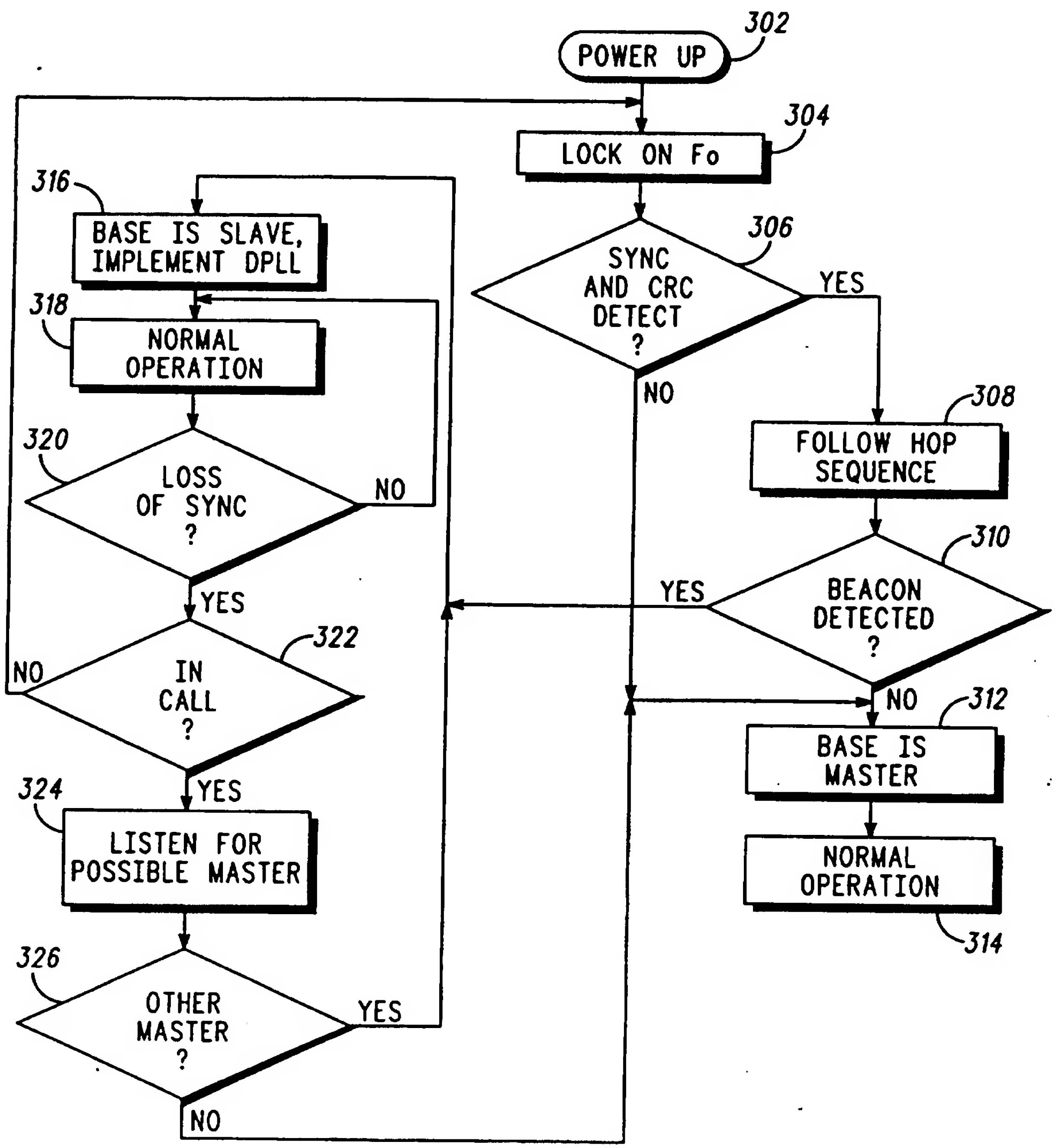

233
TELCO
217
MICROPHONE
219
AUDIO CIRCUITRY
221
SPEAKER
229
201
ASIC FRAME GENERATOR
223
TRANSMITTER
231
DPLL
215
KEYPAD
203
MICROPROCESSOR
225
SYNTHESIZER
213
DISPLAY
RECEIVER
227
211
ROM
EEPROM
RAM
209
207
205

FIG.3


POWER UP
302
LOCK ON Fo
304
SYNC AND CRC DETECT ?
306
YES
NO
FOLLOW HOP SEQUENCE
308
BEACON DETECTED ?
310
YES
NO
BASE IS MASTER
312
NORMAL OPERATION
314
BASE IS SLAVE, IMPLEMENT DPLL
316
NORMAL OPERATION
318
LOSS OF SYNC ?
320
NO
YES
IN CALL ?
322
NO
YES
LISTEN FOR POSSIBLE MASTER
324
OTHER MASTER ?
326
YES
NO

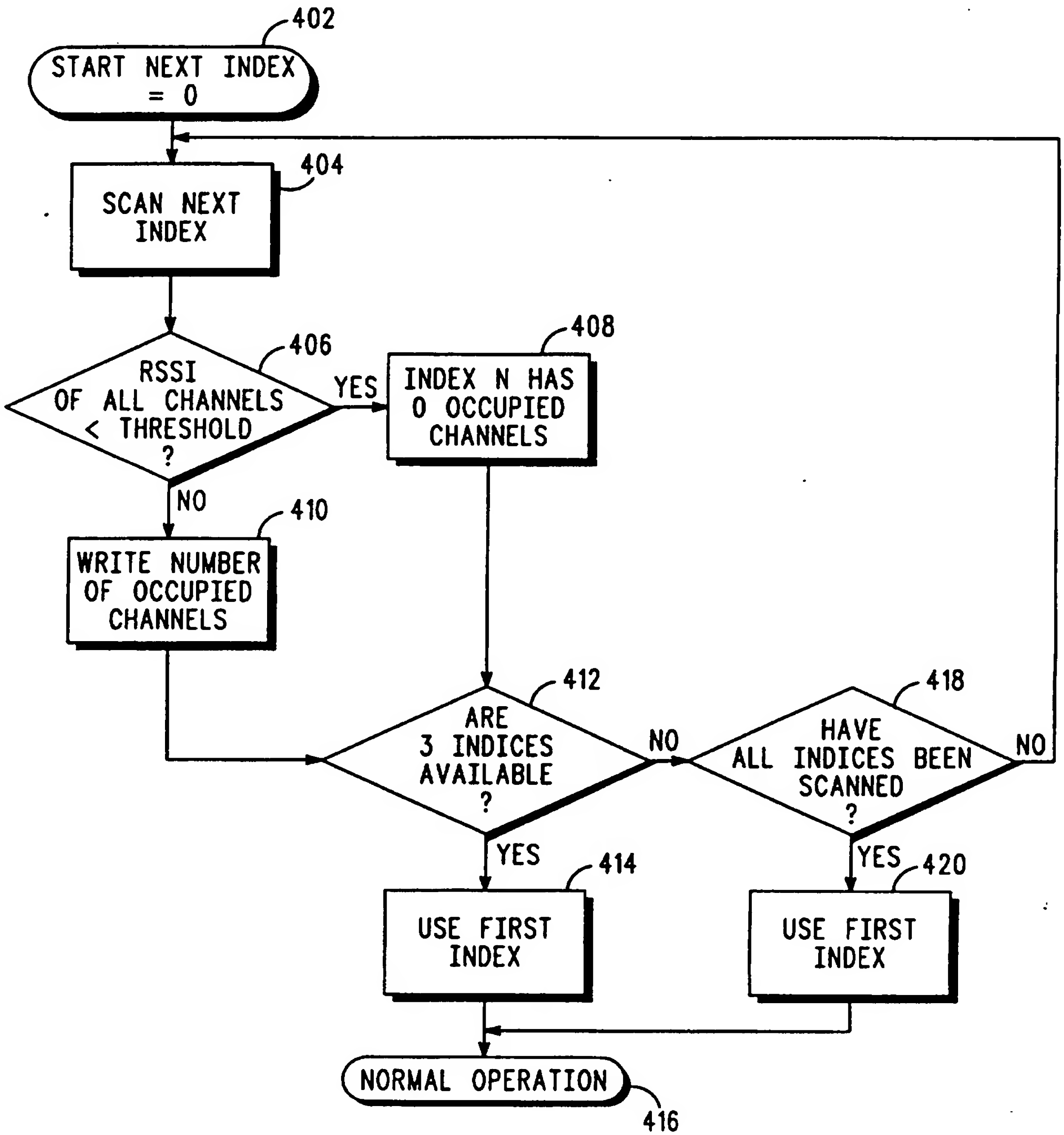

402
START NEXT INDEX = 0
404
SCAN NEXT INDEX
406
RSSI OF ALL CHANNELS < THRESHOLD ?
YES
408
INDEX N HAS 0 OCCUPIED CHANNELS
NO
410
WRITE NUMBER OF OCCUPIED CHANNELS
412
ARE 3 INDICES AVAILABLE ?
NO
418
HAVE ALL INDICES BEEN SCANNED ?
NO
YES
414
USE FIRST INDEX
YES
420
USE FIRST INDEX
NORMAL OPERATION
416

FIG.4

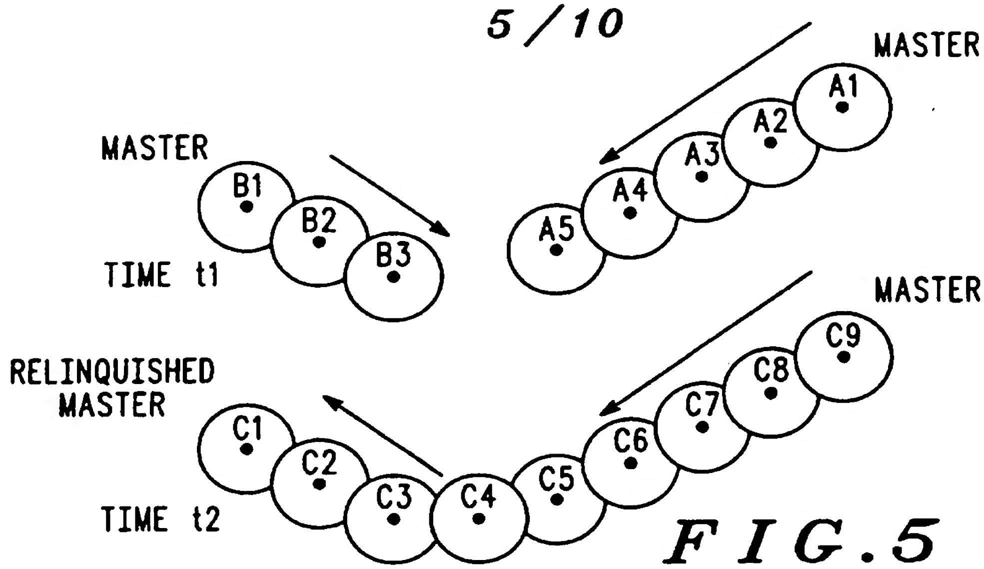

MASTER
A1
A2
A3
A4
A5
MASTER
B1
B2
B3
TIME t1
MASTER
C9
C8
C7
C6
C5
C4
C3
C2
C1
RELINQUISHED MASTER
TIME t2

FIG.5

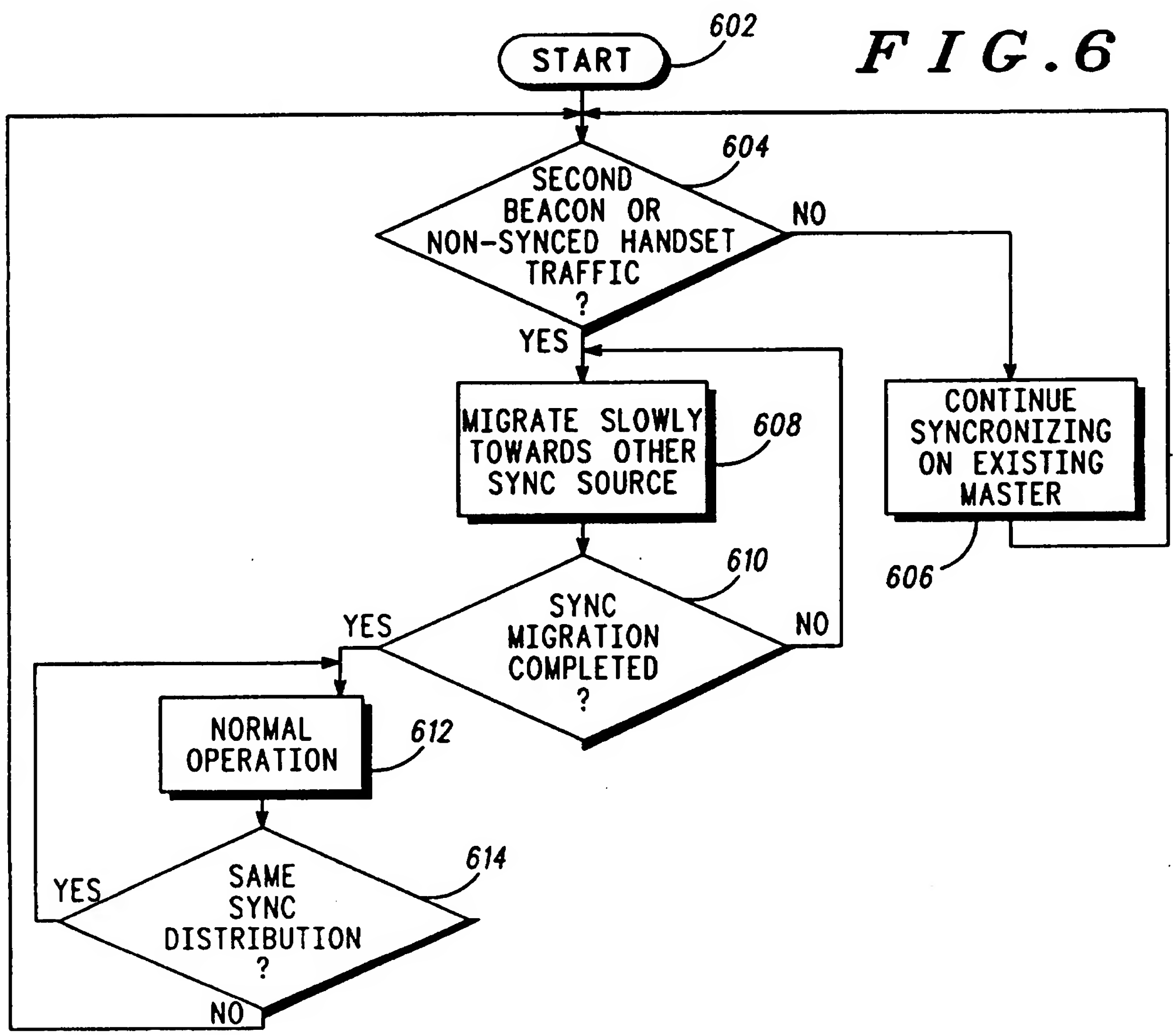

START
602
SECOND BEACON OR NON-SYNCED HANDSET TRAFFIC ?
604
NO
YES
CONTINUE SYNCRONIZING ON EXISTING MASTER
606
MIGRATE SLOWLY TOWARDS OTHER SYNC SOURCE
608
SYNC MIGRATION COMPLETED ?
610
YES
NO
NORMAL OPERATION
612
SAME SYNC DISTRIBUTION ?
614
YES
NO

FIG.6

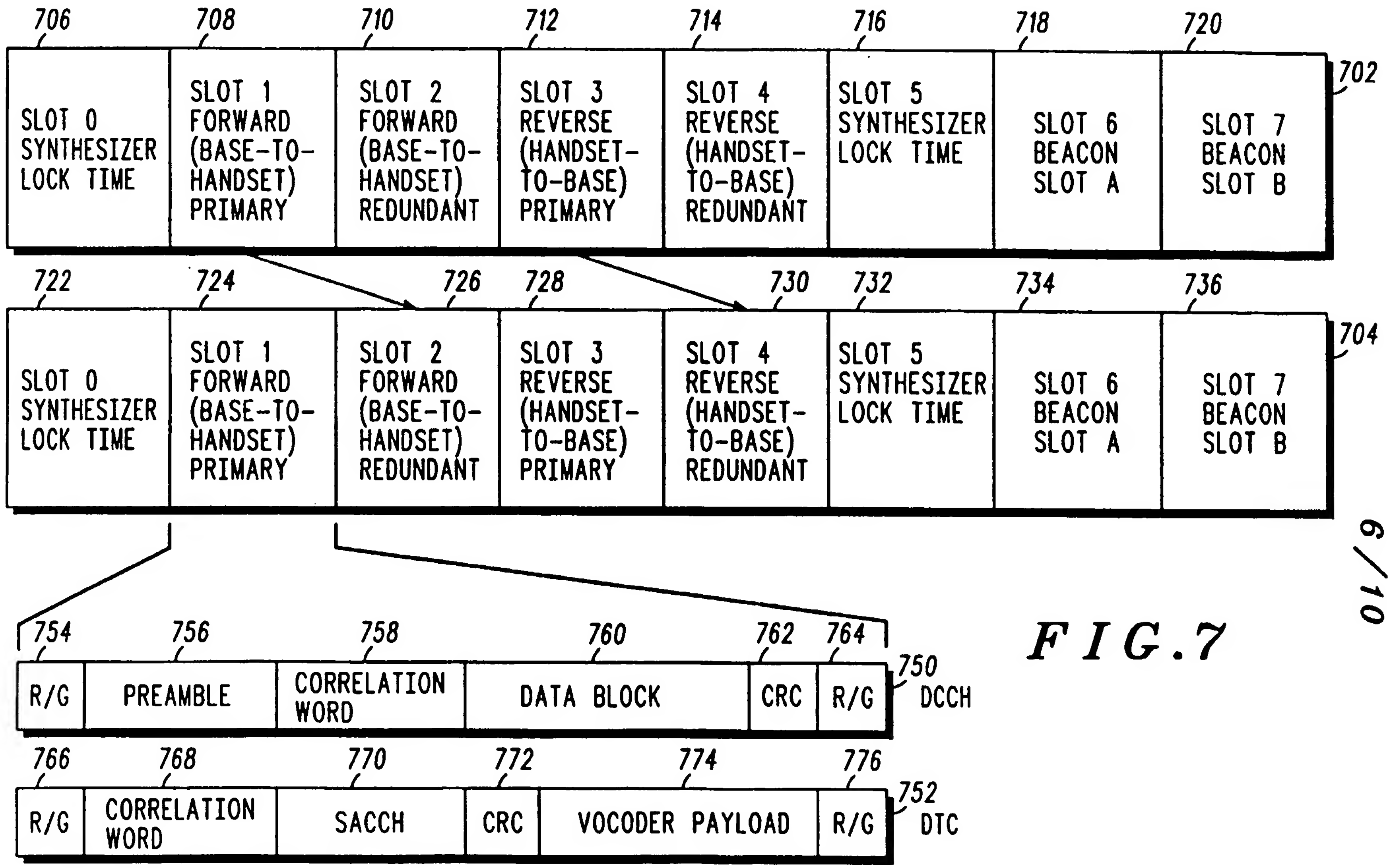

702
704
706
SLOT 0 SYNTHESIZER LOCK TIME
708
SLOT 1 FORWARD (BASE-TO-HANDSET) PRIMARY
710
SLOT 2 FORWARD (BASE-TO-HANDSET) REDUNDANT
712
SLOT 3 REVERSE (HANDSET-TO-BASE) PRIMARY
714
SLOT 4 REVERSE (HANDSET-TO-BASE) REDUNDANT
716
SLOT 5 SYNTHESIZER LOCK TIME
718
SLOT 6 BEACON SLOT A
720
SLOT 7 BEACON SLOT B
722
724
726
728
730
732
734
736
750
DCCH
754
R/G
756
PREAMBLE
758
CORRELATION WORD
760
DATA BLOCK
762
CRC
764
R/G
752
DTC
766
R/G
768
CORRELATION WORD
770
SACCH
772
CRC
774
VOCODER PAYLOAD
776
R/G

FIG.7

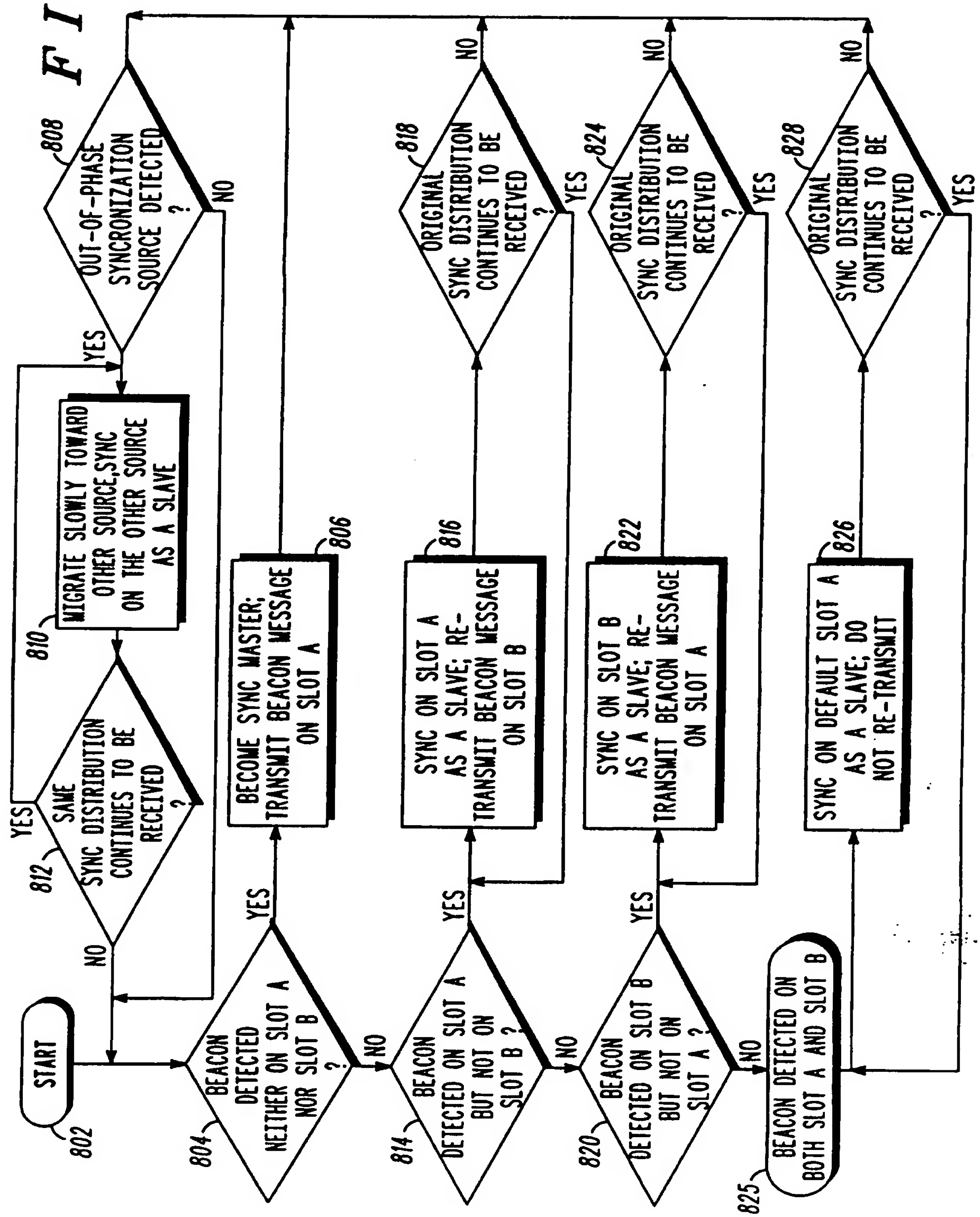
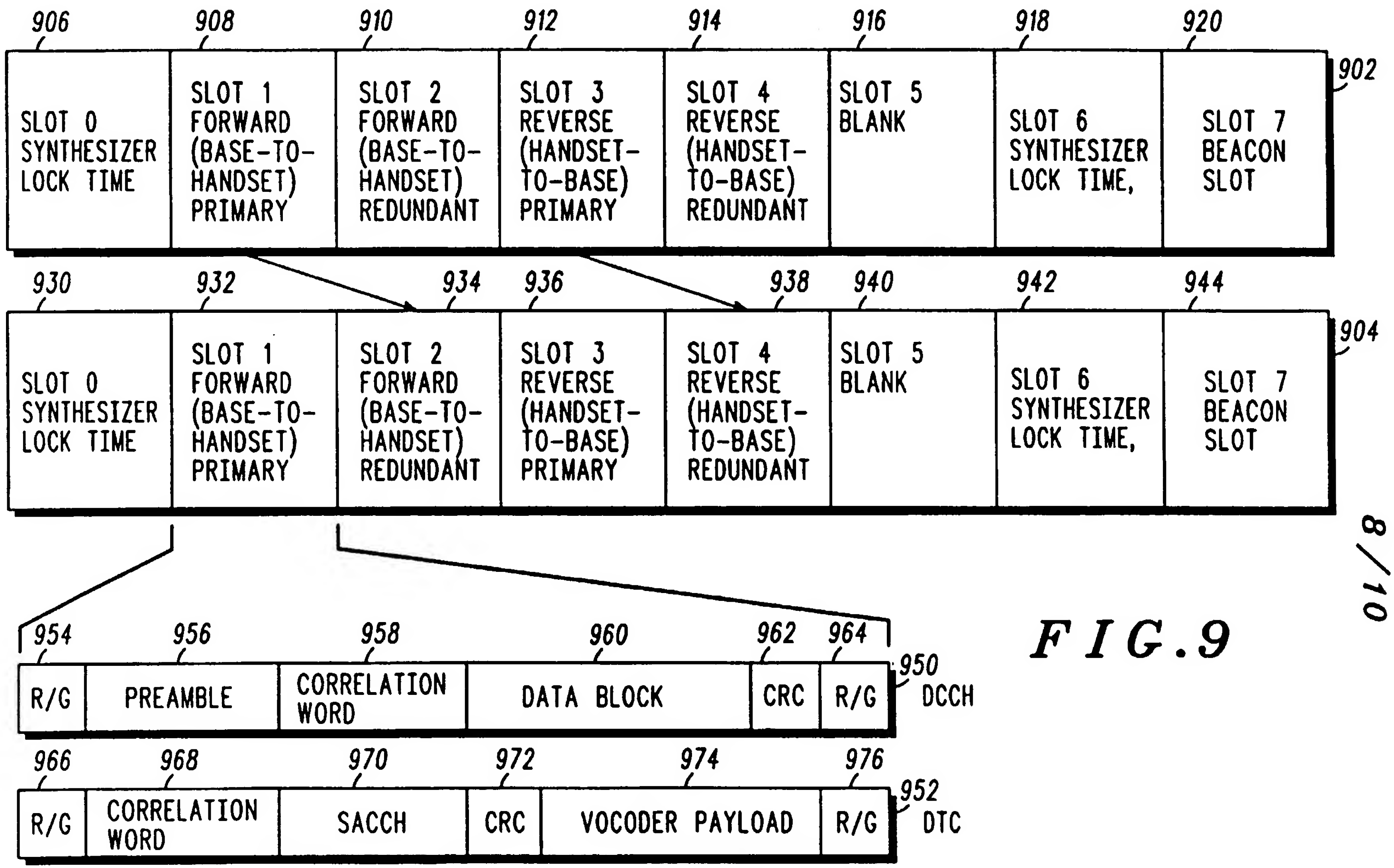

START
802
BEACON DETECTED NEITHER ON SLOT A NOR SLOT B ?
804
YES
NO
BECOME SYNC MASTER; TRANSMIT BEACON MESSAGE ON SLOT A
806
OUT-OF-PHASE SYNCRONIZATION SOURCE DETECTED ?
808
YES
NO
MIGRATE SLOWLY TOWARD OTHER SOURCE,SYNC ON THE OTHER SOURCE AS A SLAVE
810
SAME SYNC DISTRIBUTION CONTINUES TO BE RECEIVED ?
812
YES
NO
BEACON DETECTED ON SLOT A BUT NOT ON SLOT B ?
814
YES
NO
SYNC ON SLOT A AS A SLAVE; RE-TRANSMIT BEACON MESSAGE ON SLOT B
816
ORIGINAL SYNC DISTRIBUTION CONTINUES TO BE RECEIVED ?
818
YES
NO
BEACON DETECTED ON SLOT B BUT NOT ON SLOT A ?
820
YES
NO
SYNC ON SLOT B AS A SLAVE; RE-TRANSMIT BEACON MESSAGE ON SLOT A
822
ORIGINAL SYNC DISTRIBUTION CONTINUES TO BE RECEIVED ?
824
YES
NO
BEACON DETECTED ON BOTH SLOT A AND SLOT B
825
SYNC ON DEFAULT SLOT A AS A SLAVE; DO NOT RE-TRANSMIT
826
ORIGINAL SYNC DISTRIBUTION CONTINUES TO BE RECEIVED ?
828
YES
NO

FIG.8



906
908
910
912
914
916
918
920
902
SLOT 0 SYNTHESIZER LOCK TIME
SLOT 1 FORWARD (BASE-TO-HANDSET) PRIMARY
SLOT 2 FORWARD (BASE-TO-HANDSET) REDUNDANT
SLOT 3 REVERSE (HANDSET-TO-BASE) PRIMARY
SLOT 4 REVERSE (HANDSET-TO-BASE) REDUNDANT
SLOT 5 BLANK
SLOT 6 SYNTHESIZER LOCK TIME,
SLOT 7 BEACON SLOT
930
932
934
936
938
940
942
944
904
SLOT 0 SYNTHESIZER LOCK TIME
SLOT 1 FORWARD (BASE-TO-HANDSET) PRIMARY
SLOT 2 FORWARD (BASE-TO-HANDSET) REDUNDANT
SLOT 3 REVERSE (HANDSET-TO-BASE) PRIMARY
SLOT 4 REVERSE (HANDSET-TO-BASE) REDUNDANT
SLOT 5 BLANK
SLOT 6 SYNTHESIZER LOCK TIME,
SLOT 7 BEACON SLOT
954
956
958
960
962
964
950
R/G
PREAMBLE
CORRELATION WORD
DATA BLOCK
CRC
R/G
DCCH
966
968
970
972
974
976
952
R/G
CORRELATION WORD
SACCH
CRC
VOCODER PAYLOAD
R/G
DTC

FIG.9

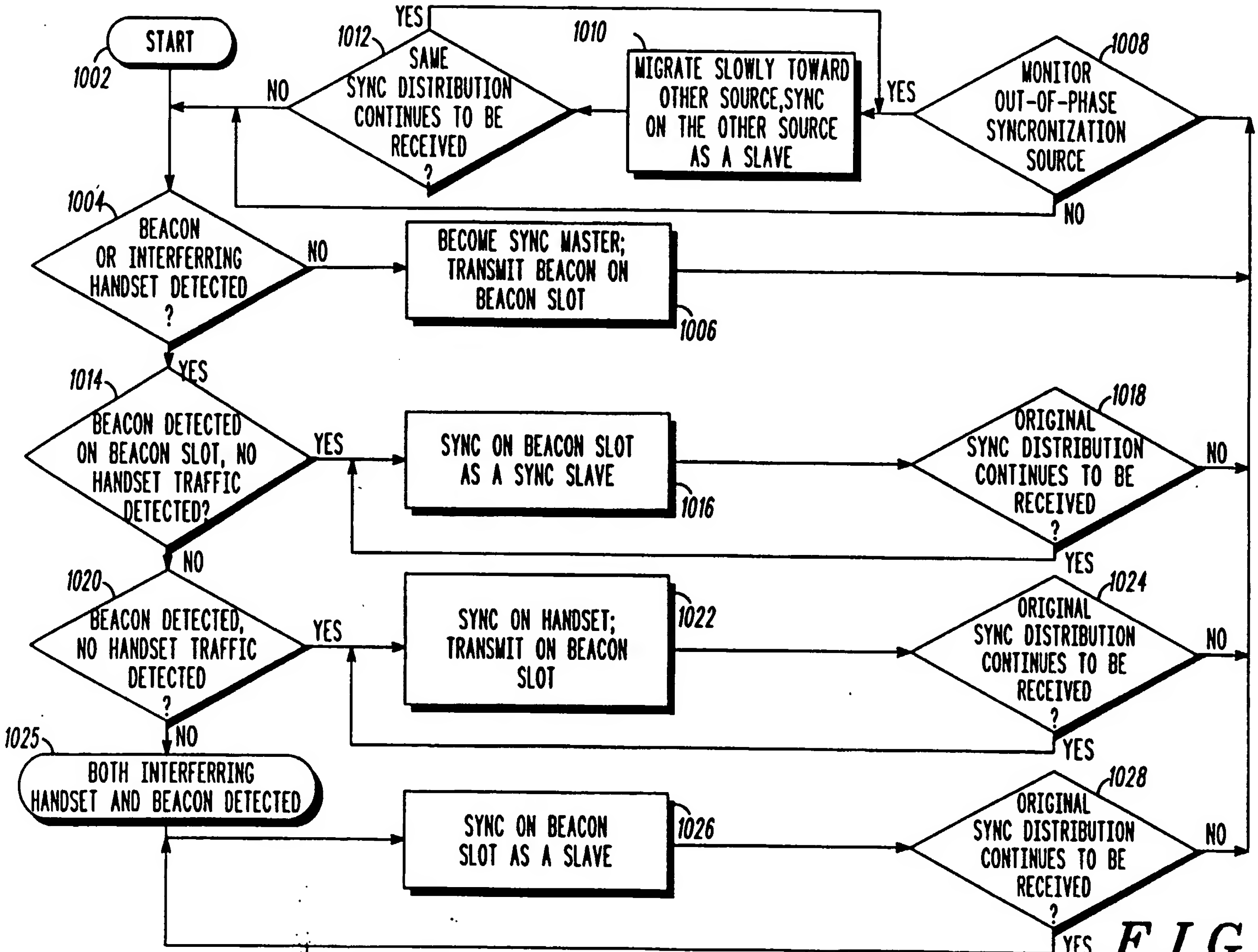

START
1002
1004
BEACON OR INTERFERING HANDSET DETECTED ?
NO
YES
BECOME SYNC MASTER; TRANSMIT BEACON ON BEACON SLOT
1006
1012
SAME SYNC DISTRIBUTION CONTINUES TO BE RECEIVED ?
1010
MIGRATE SLOWLY TOWARD OTHER SOURCE, SYNC ON THE OTHER SOURCE AS A SLAVE
1008
MONITOR OUT-OF-PHASE SYNCRONIZATION SOURCE
1014
BEACON DETECTED ON BEACON SLOT, NO HANDSET TRAFFIC DETECTED?
SYNC ON BEACON SLOT AS A SYNC SLAVE
1016
1018
ORIGINAL SYNC DISTRIBUTION CONTINUES TO BE RECEIVED ?
1020
BEACON DETECTED, NO HANDSET TRAFFIC DETECTED ?
SYNC ON HANDSET; TRANSMIT ON BEACON SLOT
1022
1024
ORIGINAL SYNC DISTRIBUTION CONTINUES TO BE RECEIVED ?
1025
BOTH INTERFERING HANDSET AND BEACON DETECTED
SYNC ON BEACON SLOT AS A SLAVE
1026
1028
ORIGINAL SYNC DISTRIBUTION CONTINUES TO BE RECEIVED ?

FIG.10

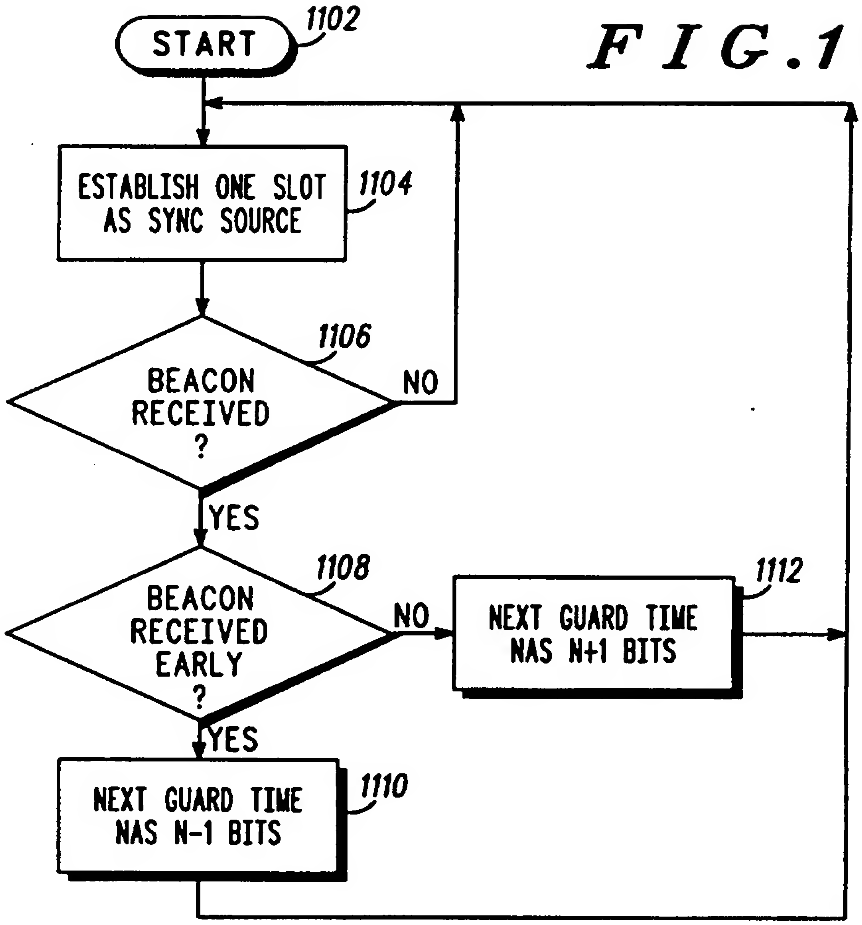

START
1102
ESTABLISH ONE SLOT
AS SYNC SOURCE
1104
BEACON
RECEIVED
?
1106
NO
YES
BEACON
RECEIVED
EARLY
?
1108
NO
NEXT GUARD TIME
WAS N+1 BITS
1112
YES
NEXT GUARD TIME
WAS N-1 BITS
1110

FIG.11

2293526

METHOD AND APPARATUS FOR PROVIDING A SYNCHRONOUS COMMUNICATION ENVIRONMENT

Field of The Invention

This invention is related to radio frequency (RF) communication systems, and more particularly to a method and apparatus for providing a synchronous communication environment.

Background of the Invention

In wireless communication systems, effort has been made to increase the use of spectrum to allow for a greater number of users of a given frequency band. One example of a technique to increase spectrum efficiency is a frequency division multiple access (FDMA) technique. In a conventional FDMA system, a given frequency band is divided into a number of channels, wherein each channel is occupied by one user. An FDMA system can also be a time division duplex (TDD) system wherein a given RF channel is used for both forward and reverse directions of communication which are separated in time.

Other techniques comprise digital multiple access communication systems. One such conventional digital multiple access technique for increasing efficiency of the use of spectrum is a time division multiple access (TDMA) technique. In a TDMA system, each channel for the transmission of signals is divided into a plurality of slots. Each time slot may be allocated to a different call. A TDMA system can also employ TDD techniques. Accordingly, a number of calls can be simultaneously transmitted on a single channel or frequency.

Finally, increased spectrum efficiency can be achieved by spread spectrum techniques, in the form of either a slow frequency hopper system or a direct-sequence CDMA system. In

a slow frequency hopper system, the carrier frequency of the signal is changed at a predetermined rate over a wide range of possible frequencies in a pseudo-random sequence known in advance by the receiver. Generally, spread spectrum techniques reduce the effects of both intentional or unintentional interference. Direct sequence CDMA systems allow multiple users to share the same spectrum wherein each user is assigned a unique psuedonoise code sequence. The signal is spread by the wide bandwidth pseudo-noise sequence known in advance by the receiver.

In digital multiple access communicationsystems having multiple base stations, there must be some coordination among the base stations to ensure that the base stations are properly synchronized. Synchronizing the base stations can be accomplished if the base stations are a part of a common system and are physically connected. However, base stations which are not physically connected must be synchronized if they are part of a common system. Further, if the base stations operate independently on common frequencies, the base stations must communicate to be properly synchronized. Accordingly, there is a need for a method and apparatus for synchronizing base stations operating in a digital multiple access communication system.

Brief Description of the Drawings

FIG. 1 is a plan view of a wireless communication system having multiple base stations coupled to the public system telephone network.

FIG. 2 is a block diagram of circuitry for a wireless base station or handset.

FIG. 3 is a flow diagram showing the preferred steps for determining master and slave designations for base station and chain building in the wireless communication system of FIG. 1.

FIG. 4 is a flow diagram for showing the preferred steps for determining an available index in a slow frequency hopper system.

FIG. 5 is a network topological diagram showing the coordination of overlapping base stations in a wireless communication systems.

FIG. 6 is a flow chart showing the general steps for the coordination of base stations during chain reversal as shown in FIG. 5.

FIG. 7 is a first embodiment of an air interface protocol having multiple sync slots for coordinating base stations.

FIG. 8 is a detailed flow diagram showing the coordination of base stations having the air interface protocol shown in FIG. 7.

FIG. 9 is a second embodiment of an air interface protocol having a single sync slot and a blank slot for coordinating base stations and handsets.

FIG. 10 is a detailed flow diagram showing the coordination of base stations having the air interface protocol shown in FIG. 9.

FIG. 11 is a flow diagram showing digital phase lock loop operation for a base with a synchronization source.

Description of the Preferred Embodiments

In a digital multiple access communication system, each base station operating within range of another base station must be synchronized to prevent interference. The present invention provides synchronous communication in a communication environment wherein multiple base stations are adapted to operate on the same frequencies. In particular, the base stations such as residential base stations must be coordinated to minimize interference with other base stations which otherwise operate independently. According to the present invention, each base station operating in a system will determine whether another base station operating on the same frequencies is within range. One of the base stations will assume a role as a master and the

remaining base station will then synchronize to the master base station. Preferred methods for synchronizing the base stations, including signaling protocols, synchronization chain building and collision avoidance techniques for building synchronization chains, are also disclosed.

Turning first to FIG. 1, a wireless communication system 102 is shown. The wireless communication system has a plurality of base stations 104, each of which provide RF coverage over an area 108. Each base station may be coupled to a public system telephone network 106. However, it will be understood that the circuit and method of the present invention could be implemented in a wireless communication system having base stations which are not coupled to a public system telephone network. The base stations could be coupled together in an independent network, or could be stand alone units which happen to operating in the same frequency bands. Each base station is also adapted to communicate with one or more handsets 110. Finally, each base station can communicate with another base station which is within range by way of RF signals.

Turning now to FIG. 2, a block diagram shows a base or handset circuit. In the preferred embodiment, an ASIC (Application Specific Integrated Circuit) 201, such as a CMOS ASIC in the MDA08 technology or H4C also available from Motorola, Inc. and microprocessor 203, such as a 68HC11 microprocessor available from Motorola, Inc., combine to generate the communication protocol shown in FIGs. 7 and 9. ASIC 201 preferably includes a separate search engine to detect a second synchronization source according to the present invention. The second search engine could be a separate digital phase lock loop (DPLL) or an oversampled cross-correlator. Digital phase lock loops are well known in the art. An example of a digital phase lock loop can be found in US Patent 3,983,498 entitled "Digital Phase Lock Loop" which issued on September 28, 1976 to Malek. The entire contents of US Patent 3,983,498 is incorporated by reference. An example of an oversampled cross-correlator can be

found in US Patent 5,117,441 entitled "Method and Apparatus For Real Time Demodulation of a GMSK Signal By A Non-Coherent Receiver" issued on May 26, 1992 to Weigand. The entire contents of US Patent 5,117,441 is also incorporated by reference.

The microprocessor 203 uses RAM 205, EEPROM 207, and ROM 209, consolidated in one package 211 in the preferred embodiment, to execute the steps necessary to generate the protocol and to perform other functions for the communication unit, such as writing to a display 213, accepting information from a keypad 215, and controlling a frequency synthesizer 225. The ASIC 201 processes audio transformed by the audio circuitry 219 from a microphone 217 and to a speaker 221. Certain message fields are constructed by the ASIC 201 and populated by the audio circuitry 219, the microprocessor 203, and others are constructed by the ASIC 201, which generates the message frame and transfers it to a transmitter 223. Transmitter 223 transmits through an antenna 229 using carrier frequencies produced by the frequency synthesizer 225 in the hopping manner chosen for the system and directed by the microprocessor 203. Information received by the communication unit's antenna 229 enters the receiver 227 which demodulates the symbols comprising the message frame using the carrier frequencies from the frequency synthesizer 225, in accord with the hopping manner chosen for the system. The ASIC 203 then parses the received message frame into its constituent parts. If the circuitry of FIG. 2 is incorporated in a residential base station, the audio circuitry of the base station may be coupled to a telco network 233.

Turning now to FIG. 3, a flow diagram shows the preferred steps for determining whether a particular base station in a wireless communication system having a plurality of base stations operating within range of one another is a master base station. The method of the present invention is preferably employed in a personal cordless base station, such as a residential or office base station, but could be employed in any system employing wireless base stations. The base station is powered up at a step 302 and

locks on a frequency f_0 at a step 304. At a step 306, the base station determines whether synchronization and cyclic redundancy check (CRC) signals are detected at a step 306. If the signals are detected, the base station follows a hop sequence at a step 308. Frequency hopping systems are well known in the art and will not be described in detail in this application. The base station then determines whether a beacon is heard at a step 310. This signal could be a beacon message generated by another source, or could be communication traffic generated by another source, such as a handset or base. If no beacon is detected at step 310, the base station assumes a role as a master base station at a step 312 and assumes normal operation at a step 314. As a master base station, the base station will hop between the various frequencies, while the other base stations will maintain synchronization with the master base station (i.e. follow the same frequency hopping pattern, but out of phase with the master, on a different hop index).

However, if a beacon is detected by the base station at step 310, the base assumes a slave role at a step 316 and implements a digital phase lock loop (DPLL). The base station assumes normal operation at a step 318, and determines whether it has lost synchronization with a master station at a step 320. If the base station has lost synchronization, it then determines whether it is in a call at a step 322. If the base station is not in a call, it locks on a frequency f_0 at step 304. However, if the base station is in a call, it listens for a possible master base station at a step 324. If the base station detects another master at a step 326, the base station assumes a slave role at step 316. The preferred methods for detecting a base station will be described in detail in reference to FIGs. 7-10. If no master is detected, the base station assumes a master role at step 312.

Turning now to FIG. 4, the preferred steps for following the hop sequence in block 308 of FIG. 3 is shown. At a step 402, the index (i.e. an offset into a predetermined sequence of channels starting with a first channel) is set equal to zero. At a step 404,

the base station scans the next index (same sequence of channels starting the second channel in the sequence) and determines if the receiver signal strength indicator (RSSI) of all channels is less than predetermined threshold at a step 406. If the RSSI of all channels is less than a predetermined threshold, the base station stores an indication that index N has zero occupied channels at a step 408. If the RSSI of all channels is not less than a threshold at step 406, the base station indicates the number of occupied channels at a step 410.

At a step 412, the base station determines whether three indices are available having no occupied channels. If three indices are available, the base station selects the first index at a step 414 and assumes normal operation at a step 416. However, if three indices are not available, the base station determines whether all indices have been scanned at a step 418. If all indices have not been scanned, the base station scans the next index at step 404. If all indices have been scanned, the base station uses the best available index depending on the least number of occupied channels having an RSSI value greater than a predetermined threshold. The three indices are used to form a next best list. If the index is corrupted during a call, a request could be sent to change the index. The next best list may be periodically updated depending upon radio resources and other limitations. While the RSSI determination is described above, evaluation of channel quality by RSSI is merely given by way of example. Any other method for determining signal quality could be used within the scope of the present invention.

Turning to now to FIG. 5, a timing diagram shows the synchronization of base stations which are within range of one another according to the present invention. Original masters A1 and B1, which are out of range of one another, are shown at time T1. Other base stations (A2 through A5) come within range of the original master A1 and synchronize to form a synchronization chain according to the steps described in FIG. 6. Similarly, base

stations B2 and B3 come within range of the original master B1 to form another synchronization chain.

As shown in FIG. 6, the method synchronizing individual chains of base stations is shown generally. The growth of the chain can be either between base stations (i.e. each base station syncs off another base station based upon a beacon message (FIGs. 7 and 8)), or a more dynamic chain with base stations detecting a beacon message or handset traffic associated with another base to form a chain (FIGs. 9 and 10). While the general concept of chain building described in FIG. 6 applies to either method for forming a synchronous chain, the general implementation for each configuration will be described separately below for ease of understanding.

In particular, the development of a synchronization chain between base stations is started at a step 602 wherein one base station becomes synchronized upon power up to an existing base station according to the steps described in FIG. 3. A base station may also be within range of and detect two sync sources. A base station determines whether a second beacon message from an unsynchronized base station is detected at step 604. If no such beacon message is detected, the base station continues synchronizing on the existing master at a step 606. However, if a second beacon message from a base station is detected, the base station synchronizes to the detected unsynchronized base station at a step 608. The base station migrates slowly towards the other base station to avoid any interruption in communication. The base station then determines whether the synchronization is completed at a step 610. If the synchronization is not completed, the base station continues to migrate slowly towards the other base station at step 608. If synchronization is completed, the base station will assume normal operation at a step 612. The base station will then determine whether the same sync distribution is received at a step 614. If the same sync distribution is received, the base station will assume normal operation at step 612. Otherwise, the base station will check for a

second beacon signal or non-synched handset traffic at step 604. One method for migrating toward another base station is described below in reference to FIG. 11.

Using the A1-A5 chain as an example, at a time T1, a base station A1 exists as an original master base station. A second base station A2 is then powered up, detects A1 and syncs to A1. A third base station A3 is then powered up. According to FIG. 3 of the present invention, A3 detects a sync source (A2) and syncs to the sync source. The chain continues to build as base stations which are powered up sync to the chain. In summary, when a base station is added to either end of the chain (i.e. is being powered up and looking for a master), the base station will sync to the chain.

At a time t2, the two synchronization chains may meet and will form a single chain of synchronized base stations C1-C9. The new base station which bridges the two chains of base stations (designated as base station C4 at time t2) will detect a first base station and sync to that base station. While C4 is within range of and could detect either C3 or C5, any collision avoidance technique could be employed to determine which base station to which C3 will sync. As will be described in detail below, the base station could sync by default to one of the two base stations. The method for default will depend upon the sychronization protocol. Assuming for example that C4 first syncs to C5, C3 (which is synced to C2) will then detect the second base station (C4) which is now out of sync and will sync to that base station. C2 (which is synced to C1) will then detect a second sync source which is out of sync (C3), and C2 will sync to C3. Finally, C1 will be out of sync with C2 and will then sync to C2 to complete the synchronization chain reversal. C1 thus relinquishes master. Accordingly, the method of the present invention will enable synchronization chains to be formed, and particularly for enabling single synchronization chains to be formed when two synchronization chains collide.

Similarly, the development of a synchronization chain based upon detecting both beacon signals and handset traffic is also described in reference to FIGs. 5 and 6. While a base station will transmit a beacon signal when power is applied to the base station, the term "power up" will also refer to the transmission of handset traffic when a base station is in a call. A base station determines whether a beacon signal or non-synced handset traffic is detected at step 604. If neither a beacon signal nor non-synced handset traffic is detected, the base station remains in the loop at a step 606. However, if a beacon signal or non-synced handset traffic is detected, the base station synchronizes to the detected base station at a step 608. The base station migrates slowly towards the detected base station to avoid any interruption in communication. The base station then determines whether the synchronization is completed at a step 610. If the synchronization is not completed, the base station continues to migrate slowly towards the other synchronization source at step 608. If synchronization is completed, the base station will assume normal operation at a step 612. The base station will then determine whether the same sync distribution is received at a step 614. If the same sync distribution is received, the base station will assume normal operation at step 612. Otherwise, the base station will check for a second beacon signal or non-synched handset traffic at step 604.

Using the A1-A5 chain again as an example, A1 is a base station exists as an original master. A base station A2 is powered up, detects a beacon signal from A1 and syncs to A1. Another base station A3 is then powered up. According to the operation of the present invention, if base station A2 is in a call, A3 detects the A2 handset traffic and syncs to A2. A3 transmits a beacon. Base station A4 is then powered up and synchronizes with base station A3. If another base station (A5) is powered up, it will sync to handset traffic of base station A4. In summary, the base stations detect either a beacon signal or handset traffic and

synchronize to the source of the beacon signal or handset traffic to form chains.

At a time t2, the two synchronization chains may meet and will form a single chain of synchronized devices C1-C9. The base station which bridges the two chains (designated as C4 at time t2) will sync to one of the two devices. While base station C4 is within range of and could detect either C3 or C5, any collision avoidance technique could be employed to determine which base station to which C3 will sync. Assuming for example that handset C4 first syncs to C5, C3 will then detect either a beacon signal or handset traffic of C4 which is out of sync and will sync to C4. C2 will then detect a second source which is out of sync (C3), and C2 will sync to C3. Finally, C1 will be out of sync with C2 and will then sync to C2 to complete the synchronization chain reversal. C1 thus relinquishes mastership.

Considering now the protocol for synchronizing communication devices, the preferred methods for synchronizing the communication devices in a chain will be described in detail in reference to FIGs. 7-10. Turning first to FIG. 7, an air interface protocol for synchronizing base stations is shown. Preferably, both primary and redundant frames 702 and 704 are transmitted between the base stations as shown in FIG. 7. A method and apparatus for maintaining frequency and bit synchronization having primary and redundant frames is described in Pickert et al., US Patent 5,212,715 entitled "Digital Communication Signalling System" which issued on May 18, 1993. Referring to the specific slots, frame 702 includes a slot 706 for synthesizer lock time. The following four slots are for forward primary and forward redundant data fields and reverse primary and reverse redundant data fields. In particular, slot 708 is for a forward (base-to-handset) primary data slot. Slot 710 is a forward redundant data field. Slot 712 is a reverse (handset-to-base) primary data field, while slot 714 is a reverse redundant data field. Slot 716 is a synthesizer time slot. The following two slots are beacon slots, designated as beacon slot A 718 (slot A) and

beacon slot B 720 (slot B). The beacon slot is used to transmit a base synchronization field which is used to synchronize the base stations. A beacon message would comprise a plurality of beacon signals transmitted on the beacon slot. The function of beacon slot A and beacon slot B will be described in detail in reference to FIG. 8.

As shown in FIG. 7, the forward primary time slot 708 of primary frame 702 is also transmitted in forward redundant slot 726 of the redundant frame 704. That is, the redundant slot contains information matching the prior frames primary slot. Similarly, the reverse primary slot 712 of primary frame 702 is transmitted in the reverse redundant slot 730 of redundant time frame 704. The operation of transmission of primary and redundant data fields is well known in the art and will not be described in further detail. However, it will be understood that a system transmitting a redundant slot need not be employed according to the present invention, and a single frame could be transmitted.

FIG. 7 also shows the preferred slot structure for a data slot either the forward or reverse direction, or a primary slot or a redundant slot in either direction. The preferred fields for a digital control channel (DCCH) field 750 is shown. Each DCCH data slot comprises a ramp/guard (R/G) field 754, a preamble field 756, a sync field 758, a data field 760, a cyclic redundancy check (CRC) field 762 and a R/G field 764. A digital traffic field 752 is also shown. The preamble field represents a marker signal for identifying the base station. In the reverse channel, the marker signal would identify the handset. The digital traffic channel data slot comprises a R/G field 766, a sync field 768, a slow associated control channel (SACCH) 770, a CRC field 772, a vocoder payload field 774, and a R/G field 776. While the preferred data field protocol is described in FIG. 7, additional or fewer fields may be transmitted within the scope of the present invention.

Referring now to FIG. 8, the preferred steps for synchronizing base stations employing the air protocol of FIG. 7 is

described. In particular, at a step 804, the base station determines whether a beacon message is acquired on either slot A or slot B. If no beacon is acquired on either slot A or slot B, the base station becomes a synchronization master and transmits a beacon message on slot A at a step 806. The base station then monitors for an out-of-phase synchronization source at a step 808. If no out-of-phase synchronization source is detected, the base station continues to determine whether a beacon message is acquired on slot A or slot B at step 804. If an out-of-phase synchronization source is detected at step 808, the base station syncs on the other base station as a slave at step 810. The base station then determines if the same sync distribution continues to be received at a step 812 (i.e. the same, previously-detected synchronization source is the only synchronization source which is detected). If the same sync distribution continues to be received, the base station syncs on the other base station as a slave at step 810.

However, if a new sync distribution is received at step 812, the base station determines whether a sync is acquired on slot A or slot B at step 804. If a sync is acquired on slot A, but not on slot B at a step 814, the base station syncs on slot A as a slave, and retransmits a beacon message on slot B at a step 816. If the original sync distribution continues to be received at a step 818, the base station continues to sync on slot A as a slave and retransmit on slot B. However, if the sync distribution does not continue, the base station monitors for an out-of-phase sync source at step 808.

If the base station detects a beacon on slot B, but not on slot A, at a step 820, the base station syncs on slot B as a slave and retransmits a beacon on slot A at a step 822. If the original sync distribution continues to be received at a step 824, the base station continues to sync on slot B as a slave and retransmit on slot A. However, if the original sync distribution is not received, the base station monitors for out-of-phase synchronization source at step 808.

Finally, if a sync is acquired both on slot A and slot B at step 825, the base station syncs on one of the slots. By way of example, the base station could sync to a default slot (e.g. slot A) at step 826. If the original sync distribution continues to be received at step 828, the base station continues to sync on slot A as a slave. Otherwise, the base station monitors for an out-of-phase synchronization source at step 808.

In summary, base station monitors two beacon slots to detect an unsynchronized source. If no beacon signal is detected in either beacon slot, the base station functions as a master base station. If the base station detects a beacon signal on one of the beacon slots, the base stations synchronizes to that base station, and retransmits a beacon signal on the other beacon slot to enable another base station to synchronize to it. If a certain base station detects a beacon on both slot A and slot B simultaneously (i.e. a beacon from two base stations), the base station will synchronize to one of the base stations. The other of the two base stations will then detect that the certain base station is out of sync and will sync to that base station. Accordingly, all of the base stations of separate chains will be synchronized.

Turning now to FIG. 9, an alternate embodiment of an air interface protocol for synchronizing base stations in a chain is shown. As shown in FIG. 9, frame 902 includes a slot 906 for synthesizer lock time. The following four slots are for forward primary and forward redundant data fields, and reverse primary and reverse redundant data fields. In particular, slot 908 is for a forward (base-to-handset) primary data slot. Slot 910 is a forward redundant data field. Slot 912 is a reverse (handset-to-base) primary data field, while slot 914 is a reverse redundant data field. At least one blank slot 916 is also included to allow for detecting handset traffic in the alternate embodiment. Slot 918 is a synthesizer lock time slot, followed by a single slot, designated as beacon slot 918. The function of the beacon slot will be described in detail in reference to FIG. 10. While both primary and redundant frames 902 and 904 are preferably transmitted

between the base stations as shown in FIG. 7, a single time frame could be transmitted. Also, the DCCH and DTC data fields described in FIG. 7 could also be employed in the alternate embodiment.

Turning now to FIG. 10, the preferred steps for the alternate embodiment for synchronizing base stations employing the air protocol of FIG. 9 having at least one blank slot and a single beacon slot is described. At a step 1004, if no beacon is detected on the beacon slot and no non-synched handset traffic is detected on the blank slot, the base station becomes a synchronization master and transmits a beacon message on the beacon slot at a step 1006. The base station then monitors for an out-of-phase synchronization source on the blank slot at a step 1008. If no out-of-phase synchronization source is detected, the base station continues to determine whether a beacon message is acquired on the beacon slot or non-synced handset traffic is detected on the blank slot at step 1004. If an out of phase handset is detected at step 1008, the base station migrates slowly toward the other source and syncs on the handset as a slave at step 1010. The base station then determines if the same sync distribution continues to be received at a step 1012. If the same sync distribution continues to be received, the base station continues to sync on the other handset as a slave at step 1010.

However, if a new sync distribution is received at step 1012, the base station determines whether a beacon message is acquired on the beacon slot or handset traffic is detected on the blank slot at step 1004. If a beacon message is detected on the beacon slot and no non-synched handset traffic is detected on the blank slot at a step 1014, the base station syncs on the beacon slot as a slave at a step 1016. If the original sync distribution continues to be received at a step 1018, the base station continues to sync on the beacon slot as a slave. However, if the sync distribution does not continue, the base station monitors for an out-of-phase sync source at step 1008.

If the base station detects non-synched handset traffic on the blank slot, but no beacon on the beacon slot at a step 1020, the base station syncs on the blank slot as a slave at a step 1022. If the original sync distribution continues to be received at a step 1024, the base station continues to sync on the blank slot as a slave and retransmits on the beacon slot. However, if the original sync distribution is not received, the base station monitors for out-of-phase synchronization source at step 1008.

Finally, if a beacon message is detected on the beacon slot and interfering handset traffic is detected on the blank slot at step 1025, the base station syncs on the beacon slot as a slave at a step 1026. If the original sync distribution continues to be received at step 1028, the base station continues to sync on the beacon slot as a slave. Otherwise, the base station monitors for an out-of-phase synchronization source at step 1008.

In summary, an alternate embodiment discloses base stations which monitor a beacon signal on a beacon slot or handset traffic on a blank slot to detect an unsynchronized source. If no beacon signal is detected on the beacon slot and no handset traffic is detected on the blank slot, the base station functions as a master base station. If the base station detects a beacon signal on the beacon slots or handset traffic on the blank slot, the base stations synchronizes to that base station. If handset traffic was detected, the base station also retransmits a beacon signal on the beacon slot to enable another base station to synchronize to it. If a certain base station detects a beacon on the beacon slot and handset traffic on the blank slot, the base station will synchronize to one of the base stations, preferably the base station detected on the beacon slot. The other of the two base stations will then detect that the certain base station is out of sync and will sync to that base station. Accordingly, all of the base stations of separate chains will be synchronized.

Turning now to FIG. 11, a preferred method for achieving or maintaining synchronization by use of a DPLL is disclosed. In particular, a slot is established as a sync source at a step 1104.

The base station will then determine whether a beacon is received at a step 1106. If a beacon is received, the base station will then determine whether the beacon is received early at a step 1108. If the beacon is received early, the base station will transmit a frame having a guard band which has N-1 bits at a step 1110. If however the beacon is not received early, the base station will transmit a guard band having N+1 bits. While the method of FIG. 11 is one method for maintaining synchronization, it will be understood that other methods which are known in the art could be employed to maintain synchronization.

In summary, the present invention provides synchronous communication in a communication environment wherein multiple base stations are adapted to operate on the same frequencies. In particular, base stations such as residential base stations must be coordinated to minimize interference with other base stations which otherwise operate independently. According to the present invention, each base station operating in a system will determine whether another base station operating on the same frequencies is within range. One of the base stations will assume a role as a master and the remaining base station will then synchronize to the master base station. Preferred methods for synchronizing the base stations, including signaling protocols and collision avoidance techniques, are also disclosed.

While specific embodiments are described by way of example in the above description, modifications and alternate embodiments fall within the spirit and scope of the present invention. The present invention should be limited only by the following claims.

We claim:

CLAIMS

1. A radio frequency (RF) digital multiple access communication system adapted to operate within range of another RF digital multiple access communication system, the RF digital multiple access communication system characterized by:

a base station characterized by:

a transmitter for transmitting communication signals, said communication signals comprising a beacon signal;

a receiver for receiving communication signals comprising a beacon signal transmitted by another base station operating within range of said RF digital multiple access communication system; and

at least one portable device adapted to communicate with said base station.

2. A radio frequency (RF) digital multiple access communication system having a plurality of independent base stations adapted to operate within range of one another, each base station characterized by:

a transmitter for transmitting communication signals, said communication signals comprising a beacon signal; and

a receiver for receiving said communication signals comprising a beacon signal transmitted by another base station operating within range of the RF digital multiple access communication system.

3. A time division multiple access (TDMA) communication system adapted to operate within range of another TDMA communication system operating in the same frequency bands with the same communications protocol, the TDMA communication system characterized by:

a personal cordless base station characterized by:

a transmitter for transmitting communication signals, said communication signals comprising a base synchronization field;

a receiver for receiving communication signals, said communication signals comprising a base synchronization field transmitted by a second personal cordless base station operating within range of the TDMA communication system; and

at least one portable device adapted to communicate with said personal cordless base station.

4. A communication device for transmitting communication signals characterized by:

circuitry for generating a message frame having a slot structure characterized by:

(i) synthesizer lock time slots;

(ii) plurality of time slots for data transmission; and

(iii) a beacon slot for synchronizing base stations operating in a communication system;

a transmitter for transmitting said message frame; and

a receiver for receiving a message frame.

5. A method for establishing communication in a wireless base station, said wireless base station being adapted to communicate with at least one remote device, said method characterized by the steps of:

listening for a beacon signal upon power-up of said wireless base station; and

establishing said wireless base station as a synchronization master if a beacon signal is not received.

6. A method for establishing synchronous communication in a first personal cordless base station, said first personal cordless base station being adapted to communicate with at

least one remote device, said method characterized by the steps of:

listening for a synchronization signal upon power-up of said personal cordless base station;

establishing said first personal cordless base station as a synchronization slave upon receiving said synchronization signal generated by a second personal cordless base station;

establishing said first personal cordless base station as a synchronization master if a synchronization signal is not received from a second personal cordless base station; and

transmitting a synchronization signal from said first personal cordless base station.

7. A method for establishing synchronous communication in a system adapted to operate with a plurality of base stations within range of one another, said method characterized by the steps of:

transmitting a beacon signal from each said base station;

listening for a beacon signal from each said base station;

establishing a first base station of said plurality of base stations as a master base station if a beacon signal is not received; and

establishing a second base station of said plurality of base stations as a slave base station upon reception of the beacon signal from said master base station.

8. A method for providing synchronous communication in a communication system having a plurality of base stations adapted to operate within range of one another, said method characterized by the steps of:

detecting a beacon signal from a first base station and a second base station at a third base station;

synchronizing said third base station to said first base station;

detecting, at said second base station, a beacon signal from a third base station; and

synchronizing said second base station to said third base station.

9. A method for providing synchronous communication in a communication system having a plurality of base stations adapted to operate within range of one another, said method characterized by the steps of:

detecting a beacon signal from each of a first base station and a second base station at a third base station;

synchronizing said third base station to said first base station;

generating a beacon signal at said third base station;

detecting, at said second base station, said beacon signal generated at said third base station; and

synchronizing said second base station to said third base station.

10. A method for providing synchronous communication in a communication system having a plurality of base stations adapted to operate within range of one another, said method characterized by the steps of:

detecting a beacon signal from each of a first base station and a second base station at a third base station;

synchronizing said third base station to said first base station;

detecting at said second base station handset traffic from a handset adapted to communicate with said third base station; and

synchronizing said second base station to said third base station based upon said handset traffic.

Patents Act 1977 **Examiner's report to the Comptroller under Section 17** **(The Search report)**	Application number GB 9518836.3
Relevant Technical Fields (i) UK Cl (Ed.O) H4L (LDSX, LDLX) (ii) Int Cl (Ed.6) H04B (7/212, 7/26) H04Q (7/30)	Search Examiner P S DERRY Date of completion of Search 30 NOVEMBER 1995
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE: WPI	Documents considered relevant following a search in respect of Claims :- 1-10

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	EP 0626796 A1	(SIEMENS) see especially Derwent Abstract	1 at least
X	EP 0592209 A1	(NIPPON) see especially page 3 lines 22 to 50	1 at least
X	EP 0578506 A2	(NEC) see especially column 10, lines 36 to 44	1, 10 at least
X	WO 94/28643 A1	(NOKIA) see whole document	1 at least
X	WO 94/22245 A1	(ERICSSON) see whole document	1 at least
X	WO 94/18764 A1	(AT & T) see Abstract	1 at least
X	WPI Accession Number 95-176189 & JP 070099473 (93JP-241565)		1 at least
X	US 5448570	(TODA) see Abstract	1 at least
X	US 5388102	(GRIFFITH) see Abstract	1 at least
X	US 4887266	(NEVE) see Abstract	1 at least

Databases:The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

80107.597WO1

& PARTNERS

Since 1959

TRADEMARKS
DESIGNS
COPYRIGHT
LICENSING
LITIGATION

Moscow
Dr. Mikhail Gorodissky (1927-2002)
Dip. Eng. Valery Medvedev, PA, EPA, TMA, DA
Dr. Econ. Anatoly Pavlovsky, PA, EPA
Dip. Eng. Sergey Dudushkin, PA, EPA, TMA, DA
Dip. Econ. Anatoly Shalikhov, TMA
Dip. Law. Vladimir Biriulin, L, PA
Dip. Eng. Yury Kuznetsov, PA, EPA, TMA, L
Dip. Eng. Sergey Dorofeev, PA, EPA, TMA
Dip. Chem. Elena Nazina, PA, EPA
Dip. Ling. Irina Korzun, TMA
Dip. Eng. Alexander Vasliets, DA, PA, TMA
Dip. Chem. Nadezhda Bannikova, PA
Dr. Chem. Andrey Fomin, PA
Dip. Eng. Evgeny Emelianov, PA, EPA
Dip. Eng. Andrey Bazhenov, PA
Dip. Eng. Alexander Mits, PA
Dip. Econ. Sergey Abubakirov, PA, EPA, TMA
Dip. Eng. Nikolay Bogdanov, PA, TMA
Dip. Eng. Vladimir Mescherlakov
Dr. Eng. Valery Jermakyan
Dr. Econ. Nikolay Karagodin, V
Dip. Ling. Ken Sasaki (Japan)
日本人スタッフ 佐々木 健

Of Counsel
Dr. Law. Igor Rabkovsky, L, PA, TMA
Dip. Eng. Natalia Lebedeva, PA, EPA
Dip. Eng. Elena Tomskaya, PA, EPA

St-Petersburg
Dip. Eng. Victor Stankovsky, PA, TMA, DA
Dip. Eng. Irina Spesivtseva, PA, EPA
Dip. Eng. Valeria Nazarova, TMA
Dip. Eng. Elena Chugorina, DA
Dip. Law. Maria Nosova, L, TMA

N.Novgorod
Dip. Eng. Irina Shishko, TMA
Dip. Eng. Lev Kovalchuk, PA, TMA, DA, L
Dip. Chem. Ludmila Pozina

Samara
Dip. Ling. Galina Skrebkova, TMA
Dip. Law. Tatiana Vernigora, L, TMA
Dip. Eng. Oksana Tsepova, TMA
Dip. Eng. Anatoly Churikov

Krasnodar
Dip. Law. Vadim Bloshentsev, L
Dip. Eng. Natalia Avdeeva, PA, TMA, DA

Ekaterinburg
Dip. Eng. Sergey Egorov, TMA
Dip. Eng. Boris Oborin, PA, TMA
Dip. Eng. Ekaterina Glebova, TMA
Dip. Law. Evgeny Dedkov, L

Kiev
Dip. Eng. Nina Moshinskaya, PA, TMA, DA, L
Dip. Ling. Sergey Novikov, PA, TMA, DA, L
Dip. Ling. Yuliya Grabovska, TMA, DA, PA, L
Dip. Eng. Natalia Breus, PA, DA, TMA, L
Dip. Law. Konstantin Sikachin, TMA, DA, PA, L
Dip. Econ. Dina Krivoshey, PA, TMA, DA, L
Dip. Eng. Sergey Kuzmenko, PA, TMA, DA, L

PA - Patent Attorney
EPA - Eurasian Patent Attorney
TMA - Trademark Attorney
DA - Design Attorney
L - Lawyer
V - Valuer

Moscow
St-Petersburg
N.Novgorod
Samara
Ekaterinburg
Krasnodar
Kiev (Ukraine)

INTELLEVATE
PO Box 52050
900 Second Avenue South
Suite 1700 Minneapolis
MN 55402
USA
Att: Ms. Meredith J. Mescher

BY FAX & DHL

Date: February 27, 2007

YourRef: P22709F
OurRef: 2420-300714RU/042
Country: RUSSIA
ApplNo: PCT/RU2006/000101
PatNo:

In the name of:
INTEL CORPORATION

Dear Sirs,

Please find enclosed the Communication relating to the results of the partial International Search and the Invitation to pay additional fees emitted by the International Search Authority.
Please note that the payment of additional fees is due by **March 16, 2007**.
Please provide us with your instructions to pay the additional fees one week before the due date.

Yours faithfully,

Alexander Mits
Chief of Filing Department

INTELLEVATE
FEB 28 2007
RECEIVED
Coded tao Verified

Client's code - US53105

Address:
Law firm "Gorodissky & Partners" Ltd.
B. Spasskaya str., 25, stroenie 3
Moscow, 129090, Russia

Telephone:
+7 (495) 937 6116 / 6109

Fax:
+7 (495) 937 6104 / 6123

Internet:
E-mail: pat@gorodissky.ru
http://www.gorodissky.com

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:
LAW FIRM GORODISSKY & PARTNERS LTD.
Attn. Egorova, Galina
Bolshaya Spasskaya str. 25
stroenie 3
Moscow 129010
FEDERATION DE RUSSIE

Registered

PCT

INVITATION TO PAY ADDITIONAL FEES

(PCT Article 17(3)(a) and Rule 40.1)

	Date of mailing (*day/month/year*) 16/02/2007
Applicant's or agent's file reference 300714 RU/042	**PAYMENT DUE** within ONE MONTH from the above date of mailing
International application No. PCT/RU2006/000101	International filing date (*day/month/year*) 06/03/2006
Applicant INTEL CORPORATION	

1. This International Searching Authority

(i) considers that there are 2 (*number of*) inventions claimed in the international application covered by the claims indicated ~~below~~/on the extra sheet:

and it considers that the international application does not comply with the requirements of unity of invention (Rules 13.1, 13.2 and 13.3) for the reasons indicated ~~below~~/on the extra sheet:

(ii) [X] has carried out a partial international search (see Annex) [ ] will establish the international search report on those parts of the international application which relate to the invention first mentioned in claims Nos.:
1-16

(iii) will establish the international search report on the other parts of the international application only if, and to the extent to which, additional fees are paid

2. The applicant is hereby invited, within the time limit indicated above, to pay the amount indicated below:

EUR 1,615.00 x 1 = EUR 1,615
Fee per additional invention / number of additional inventions / total amount of additional fees

Or, ______ x ______ = ______

The applicant is informed that, according to Rule 40.2(c), the payment of any additional fee may be made under protest, i.e., a reasoned statement to the effect that the international application complies with the requirement of unity of invention or that the amount of the required additional fee is excessive.

3. [ ] Claim(s) Nos. ______ have been found to be unsearchable under Article 17(2)(b) because of defects under Article 17(2)(a) and therefore have not been included with any invention.

Name and mailing address of the International Searching Authority	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Carina Bergström

Date G&P: 26/02/2007

0003082336

Annex to Form PCT/ISA/206

COMMUNICATION RELATING TO THE RESULTS OF THE PARTIAL INTERNATIONAL SEARCH

International Application No
PCT/RU2006/000101

1. The present communication is an Annex to the invitation to pay additional fees (Form PCT/ISA/206). It shows the results of the international search established on the parts of the international application which relate to the invention first mentioned in claims Nos.:
see 'Invitation to pay additional fees'

2. This communication is not the international search report which will be established according to Article 18 and Rule 43.

3. If the applicant does not pay any additional search fees, the information appearing in this communication will be considered as the result of the international search and will be included as such in the international search report.

4. If the applicant pays additional fees, the international search report will contain both the information appearing in this communication and the results of the international search on other parts of the international application for which such fees will have been paid.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 293 526 A (MOTOROLA INC [US]) 27 March 1996 (1996-03-27) page 3, line 24 - page 4, line 5	1,9
A	US 6 477 385 B1 (HARA YUTAKA [JP]) 5 November 2002 (2002-11-05) column 1, line 38 - column 2, line 56	1-16
A	US 5 822 361 A (NAKAMURA KAZUNORI [JP] ET AL) 13 October 1998 (1998-10-13) column 3, lines 13-33 column 7, lines 1-57	1-16

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

International application No.
PCT/RU2006/000101

INVITATION TO PAY ADDITIONAL FEES

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-16

claims 1-16: if another base station in the vicinity of a base station is interfering, than this interfering neighbour is identified and made a master base station, i.e. the other base stations have to synchronize with the master base station;

---

2. claims: 17-30

claims 17-30: establish and maintain synchronization with the master base station by receiving its ID and ranging code, synchronizing and refreshing the synchronization by reading periodically received new ranging codes;

This Authority considers that there are 2 inventions covered by the claims indicated as follows:

I: Claims 1-16 directed to choosing a base station as a master base station to which other BS have to synchronize
II: Claims 17-30 directed to maintaining/refreshing synchronization to a master base station

The reasons for which the inventions are not so linked as to form a single general inventive concept, as required by Rule 13.1 PCT, are as follows:

The features common between claim 1 and claim 17 are a method comprising initially synchronizing to said master base station.

These common features are not novel, see GB2293526, they can thus not serve as the common inventive concept. All other features in claims 1 have no correspondance in claim 17. Also all other features in claim 17 have no correspondance in claim 1.

The prior art has been identified as document GB2293526 and discloses:

A method comprising: acquiring information about interfering base stations in a vicinity of a base station of interest (see D1, page 3, line 32-34); and choosing one of said interfering base stations as a master base station (see D1, page 3, line 35) for said base station of interest, wherein a master base station is a base station to which another base station is to synchronize (see D1, page 4, line 1-2).

Claim 1 is thus not novel.

The special technical feature added by claim 2 is the determination if said interfering base stations are from multiple sync groups, which is a group of base stations that are currently synchronized with one another,

INVITATION TO PAY ADDITIONAL FEES

International application No.
PCT/RU2006/000101

selection of a master sync group and a modified selection process of a master base station resulting therefrom. It follows that these technical features of claim 1 make a contribution over the prior art and can be considered as special technical features within the meaning of Rule 13.2 PCT.

The problem solved by these special technical features can therefore be construed as how to coordinate multiple sync groups.

Neither are the features found in claim 17 nor is the same problem adressed nor is the same technical effect achieved.

Examining the possible correspondence by technical effect, one finds that the technical effect of the first invention is the selection of a master base station, and that the technical effect of the second invention is refreshing synchronization with a master base station.

This appears to show lack of corresponding technical effect as well. Consequently, neither the objective problem underlying the subjects of the claimed inventions, nor their solutions defined by the special technical features allow for a relationship to be established between the said inventions, which involves a single general inventive concept.

In conclusion, the groups of claims are not linked by common or corresponding special technical features and define 2 different inventions not linked by a single general inventive concept. The application, hence does not meet the requirements of unity of invention as defined in Rules 13.1 and 13.2 PCT.

It has to be noted however that it appears that claim 17 could easily be drafted as a dependent claim to claim 1 defining steps performed subsequently to the steps of claim 1. At least the requirement of unity would then be satisfied.

Information on patent family members

International Application No
PCT/RU2006/000101

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
GB 2293526	A	27-03-1996	BR	9504135	A	30-07-1996
			CA	2157727	A1	24-03-1996
			CN	1126931	A	17-07-1996
			DE	19535301	A1	28-03-1996
			FR	2725088	A1	29-03-1996
			JP	8102977	A	16-04-1996
			SE	9503284	A	24-03-1996
			SG	64846	A1	25-05-1999
			US	5784368	A	21-07-1998
US 6477385	B1	05-11-2002	AU	769764	B2	05-02-2004
			AU	4115599	A	17-02-2000
			CN	1496163	A	12-05-2004
			CN	1249650	A	05-04-2000
			JP	2000050351	A	18-02-2000
US 5822361	A	13-10-1998	JP	3223055	B2	29-10-2001
			JP	8139723	A	31-05-1996

Important Information

General

- The **claims cannot be changed** at this point in the procedure, the transmitted report is **not** the International search report (see Art. 19 PCT).
- Any payment has to be made **directly** to this ISA, payments to other entities will not be accepted.
- In case of a **total of more than 2 inventions** found: when paying please **specify exactly** which claims should be searched.
- An **extension of** the set **time limit** cannot be granted.

Payment by cheque:

- The **date to be considered as the date on which the payment is made** is the **date of receipt of the cheque at the EPO,** provided that the cheque is **met**.
- Copies of cheques sent by fax or by post are not considered to be a valid payment.
- The fees shall be paid in euro, no equivalents in other currencies.

Payment or transfer to a bank account:

- The **date to be considered as the date on which the payment is made** is the date on which the amount of the payment or the transfer is **actually entered** in a bank account or Giro account held by the EPO.
- The fees shall be paid in euro, no equivalents in other currencies.

Payment by deposit account:

- The **date to be considered as the date on which the payment is made** is the date that the **authorisation** to deduct fees from the deposit account is **received at the EPO.**

Note: *If you don't have a deposit account with the EPO yourself you might want to consider using the account of an associate as a safe and quick way of paying.*

Payment by credit card:

- Payments by **credit card** are **not possible.**

Payments under protest according to Rule 40 PCT:

- The protest will **not be accepted without a payment** of additional fees.
- The protest has to be **accompanied by a technical reasoning.**

New amounts for procedural fees as from 01/04/2006 (see OJ EPO 2006,8)!

- additional search fee: EUR 1615,00
- protest fee: EUR 1065,00

Important information

Rule 40 PCT has been amended as of 1 April 2005. For general information on the protest procedure at ISA/EP, please refer to OJ EPO 3/2005, pages 226/227.

1. As in the past the payment of any additional fee may be made under protest i.e. accompanied by a reasoned statement to the effect that the international application complies with the requirement of unity of invention or that the amount of the required additional fees is excessive according to amended Rule 40.2(c) PCT.

2. After due receipt of the payment of the additional search fee(s) under protest (i.e. within one month from the date of the invitation), the EPO will, prior to examination of the protest by the Board of Appeal, subject the invitation to pay additional fees to an internal review. The result of this review will be communicated to the applicant.

3. The fee for examination of the protest (Rule 40.2(e) PCT) is payable within one month from the date of the invitation to pay additional fees (Rule 40.1(iii) PCT). However, in order to allow the applicant to consider the result of the internal review, the applicant may pay the protest fee within one month from the date of notification of the result of the review.

4. Should the applicant wish to maintain his protest in light of the review he must pay the protest fee within one month from the date of notification of the result of the internal review, in which case the protest will be referred to the Board of Appeal. Should the Board of Appeal find that the protest was entirely justified, the protest fee shall be refunded.

5. In the event of the applicant already having paid the protest fee before notification of the result of the review, the protest will be referred to the Board of Appeal **unless** the result of the internal review was that the protest was **entirely** justified **or** the applicant indicates within one month from the date of notification of the result of the review that he does not wish to continue the protest. In both cases, the protest fee will be refunded.